STATUS OF MINERAL RESOURCE INFORMATION FOR ASSORTED INDIAN LANDS IN ARIZONA
Pascua-Yaqui Reservation, Camp Verde Reservation, and Payson Indian Community

by

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SUMMARY AND CONCLUSIONS

The Pascua-Yaqui, Payson, and Camp Verde Reservations contain few known mineral resources. It is unlikely that further study will reveal major resources on any of the reservations although the Payson Indian Community may contain small amounts of gold and some of the Camp Verde parcels may contain evaporite deposits, such as salt or sodium sulfate.

Available records reveal no known commercial mineral or petroleum deposits on tribal lands, although important mineral commodities occur within short distances of each reservation. Little petroleum exploration has taken place near the three reservations, and no test wells have been drilled on tribal lands. Oil companies now are evaluating an area known as the Overthrust Belt, a strip of intense deformation that extends from Alaska through Mexico. Because two of the three reservations are within this belt of extremely complex folded and faulted rocks, they may have some possibilities of future oil discoveries.

INTRODUCTION

This report was prepared for the Bureau of Indian Affairs (BIA) by the U. S. Geological Survey (USGS) and the U. S. Bureau of Mines (USBM) under an interagency agreement to compile and summarize available information on the geology, mineral resources, and economic development potential of certain Indian lands. Source materials included published and unpublished reports and personal communications.

Three reservations are discussed in this report. The Pascua-Yaqui Reservation is in Pima County, directly southwest of Tucson and north of the San Xavier Indian Reservation. The Payson Indian Community in Gila County borders the southern part of the town of Payson and lies partially within the Payson corporate boundary. The Camp Verde Reservation in Yavapai County consists of five parcels lying between Clarkdale and Camp Verde. The locations of the three reservations, and of some of the other Indian reservations in Arizona, are shown on Figure 1.

In preparing this report, duplicate names were encountered for two mining districts near the towns of Camp Verde and Payson. The name "Verde" mining district has referred consistently to the district near Camp Verde, but "Verde" as well as "Green Valley" and "Payson" also have been used for a district near Payson. In this study, the mining district near Camp Verde is called "Verde" mining district and that near Payson is called the "Green Valley" mining district.

Another inconsistency in nomenclature is the use of several names for the reservation near Payson; it is shown as the "Yavapai-Tonto" Reservation on the BIA highway map. The reservation is labeled "Tonto-Apache" on a sign at the entrance to the tribal lands, but the 1974 edition of the Department of Commerce publication, "Federal and State Indian Reservations and Indian Trust Areas", refers to it as the "Payson Community of Yavapai-Apache Indians". The USGS's South Payson quadrangle map designates this same reservation as the "Payson Indian Reservation". The name used in this study is the "Payson Indian Community", recommended by the BIA in Phoenix, Arizona (Crowther, 1981, personal communication).

Location and Access

Road access to the reservations under study is generally good. The Pascua-Yaqui Reservation lies south of Valencia Road, a major east-west artery about 6 miles south of Tucson. The connecting road south of Valencia Road is paved for 1 mile, and an additional ¼ mile into the reservation is unpaved. The Payson Indian Community has direct access to State Highway 87. The five parcels of the Camp Verde Reservation are accessible from either Interstate Highway 17, U. S. Highway 89A, or State Highway 279.

No direct railroad access to the reservations is available; the Clarkdale Parcel of Camp Verde has the nearest rail service. A branch of the Santa Fe Railroad, providing service to a cement plant, is about ½ mile northwest of the reservation. The Tucson-Nogales branch of the Southern Pacific Railroad is about 6 miles east of Pascua-Yaqui Reservation. Payson Indian Community lands are about 60 miles from a railroad.

Two airports are close to Camp Verde tribal lands--the unpaved Rimrock Airport is less than 1 mile north of the Rimrock Parcel, and an unpaved airstrip is about 1 mile southeast of the Lower Verde Parcel. The Middle Verde Parcel is about 7 miles northwest of the second airstrip.

At greater distances from airport facilities are the Pascua-Yaqui Reservation (about 6 miles west of Tucson International Airport), the Payson Indian Community (about 3 miles southeast of Payson Airport), and the Clarkdale Parcel (about 2½ miles northwest of Cottonwood Airport).

Arizona is divided into two physiographic provinces by the Mogollon Rim, a feature that extends diagonally across the State from northwest to southeast (Figure 1). The northeast half of the State is in the Colorado Plateau province, and the southwest half in the Basin and Range province. These provinces merge in a transition zone (Wilson and Moore, 1959, p. 89), which shows characteristics of both, and is sometimes referred to as the Central Mountains or Mountain region (Peirce and others, 1977) (Figure 1). Both the Camp Verde Reservation and the Payson Indian Community are in the transition zone. The third reservation, the Pascua-Yaqui, is in the Basin and Range province.

Map Coverage

TABLE 1
Tribal Land and Appropriate USGS 7.5-minute Quadrangle Maps

Reservation or parcel	Quadrangle map
Pascua-Yaqui	San Xavier Mission
Payson Indian Community	Payson South
Camp Verde	
Clarkdale Parcel	Clarkdale
Middle Verde Parcel	Cornville Middle Verde
Lower Verde Parcel	Camp Verde
Rim Rock Parcel	Lake Montezuma
Tract 37 Parcel	Camp Verde

PASCUA - YAQUI INDIAN RESERVATION

Setting

Located 5 miles southwest of Tucson, Arizona, in Pima County, the Pascua-Yaqui Reservation (Figure 2) is occupied by the Yaqui tribe. Tribal lands encompass about 203 acres in southern Arizona in the NE¼ and NW¼ sec. 24, T 15 S, R 12 E. Tribal affairs are handled through the Bureau of Indian Affairs, Fort McDowell Agency.

Principal economic activities in the vicinity of the reservation are tourism, farming, livestock grazing, and mining. Because of its close proximity to Tucson, a rapidly growing city, land values should increase.

The Pascua-Yaqui Indian Reservation is within the Basin and Range physiographic province, characterized by elongate, north-trending, block faulted mountains, separated by broad valleys. The reservation itself is on the west side of the broad, alluvium-filled, Santa Cruz Valley between the Tucson Mountains and Black Mountains at altitudes between approximately 2,560 and 2,580 feet.

Previous Investigations

Past geological studies have been mainly reconnaissance, such as regional ground water studies (Arizona Underground Water Commission, 1953) or mapping done in conjunction with the State mapping program in the 1950's (Forrester, 1962). Mining investigations mainly consist of listings or brief discussions of known mines and/or mineral occurrences (for example: Moore, 1972; Keith, 1974; Turney, 1978), or detailed geologic and geophysical investigations of individual mining districts or properties (for example: Jenkins and others, 1920; Gilluly, 1937, 1938; Arizona Department of Mineral Resources, 1961). The only specific studies of the Tucson Mountain Mining district are by Jenkins and others (1920), who describe the geology of the Tucson and Amole Mountains in the vicinity of the reservation and the report on the Amole district by Kinnison, 1958. The "Mineral and Water Resources of Arizona" by the Arizona Bureau of Mines (1969) lists various resources and their known occurrences in Arizona. Keith (1974) studied the geology and mineral deposits of Pima County, including the reservation.

Geology

The reservation is at the southern end of the Tucson Mountains, a northwest-trending range in the southern Basin and Range physiographic province. These mountains form a tilted lava-capped range containing sedimentary rocks ranging from Cabrian to Cretaceous in age, volcanic rocks from Cretaceous to Pleistocene, and intrusive rocks of Cretaceous and (or) Tertiary (Laramide) age. Brown (1939) provided the first detailed description of the Tucson Mountains. Kinnison (1959a) reinterpreted some of the structural features shown by Brown (1939), including a complicated thrust fault that Kinnison showed to be a chaotic sedimentary formation.

Most of the Paleozoic sedimentary rocks in the Tucson Mountains are sandstones and limestones, and they occur in the northern part of the range; however, Permian limestone has been found in the central part of the mountains, 3 miles west of Cat Mountain, which is 5 miles north of the reservation (Brown, 1939).

The Mesozoic rocks have been divided into three units. The Recreation Redbeds of Triassic or Jurassic age (Hayes and Drewes, 1978), consist of brick-red fine-grained sandstone that grades into andesite pebble conglomerate with thin interbedded rhyolite flows, and crop out in the west central part of the range. An undifferentiated unit consisting primarily of andesite occurs only in the northern part of the Tucson Mountains. The Cretaceous Amole Arkose is abundant in the southern part of the range and consists of gray to pink coarse-grained arkose interbedded with shales and a few limestone beds (Brown, 1939; Fergusson, 1959).

Laramide deformation produced folding and faulting and probably also metamorphism of the older sedimentary rocks. Granite, quartz monzonite, and latite stocks were intruded in a number of places throughout the Tucson Mountains including one at Saginaw Hill, 2 miles north of the reservation (Figure 2). This stock is a latite porphyry with feldspar phenocrysts as large as 0.75 inches, smaller but more abundant quartz phenocrysts, and some biotite phenocrysts (Brown, 1939). Most of the Paleozoic and Mesozoic sedimentary units are locally metamorphosed near Laramide intrusive bodies. Near stocks the limestone has been changed to epidote-garnet skarn with well preserved bedding and the shale has been metamorphosed to hornfels. Shale and arkose have been silicified.

A sequence of Tertiary volcanic rocks consisting of interbedded silicic to intermediate lavas and tuffs covers most of the eastern slope of the range (Brown, 1939). These rocks have been divided into several formations in the southern part of the Tucson Mountains. The Cat Mountain Rhyolite extends south from Amole Peak to east of Beehive Peak. It ranges in color from dark reddish brown to buff. The base of this unit contains sedimentary fragments of underlying units and the upper portion of the unit consists of small quartz, orthoclase, and biotite phenocrysts in a glassy to cryptocrystalline groundmass. The Safford Tuff, a chalky white unit, consisting of quartz, feldspar, and fine-grained felsic material may occur west of Beehive Peak. It is fine grained and well stratified. A massive diopside andesite southwest of Beehive Peak is gray green when fresh, weathers brown, and consists of andesite and diopside phenocrysts in a plagioclase-rich groundmass. A red to gray massive biotite rhyolite on the eastern slope of Beehive Peak contains phenocrysts of quartz and feldspar, and includes xenoliths of underlying rocks near its base. The Shorts Ranch Andesite in the southern part of the Tucson Mountains is light purplish gray with oligoclase and biotite and (or) hornblende phenocrysts in a crystalline groundmass. A rhyolite neck at Beehive Peak consists of quartz, biotite, and altered feldspar in a crystalline groundmass. This rock is similar to the biotite rhyolite and may be its source (Brown, 1939).

The Black Hills at the southern tip of the Tucson Mountains (Heindl, 1959) contain a sequence of basaltic andesite flows that dip gently to the north (Percious, 1968). The base of this sequence contains dikes and a flow of a quartz-bearing basalt. Several light colored flows in the sequence previously described as rhyolite (Heindl, 1959) are petrologically the same as the other basaltic andesite flows. A conglomerate, locally termed the San Xavier conglomerate, in the Black Hills contains pebble- to boulder-size fragments of Cretaceous arkose, siltstone, mudstone, rhyolite,

and andesite (Heindl, 1959). The Black Hills are structurally a horst, which formed after eruption of the andesites (Percious, 1968).

Alluvial deposits forming the bajadas on which the reservation is situated are derived from the Sierrita Mountains, southwest of the Tucson Mountains (Heindl, 1959). Part of the reservation is also located in adobe flat deposits that consist of reddish-brown silt and sand containing small amounts of gravel. These are being eroded by sheet wash and reworked by wind action. Cooley (1973) estimated the thickness of alluvial deposits in the vicinity of the reservation to be less than 400 feet. The alluvium is thinnest in the northeast part of the map area (Figure 3), east of the reservation, and thickens to the southwest.

The Sierrita Mountains south of the reservation contain a Proterozoic granitic core flanked by metamorphosed Paleozoic and Mesozoic sedimentary and volcanic rocks. On the eastern side of the mountains are limestone, quartzite, shale, andesite, and rhyolite that have been folded, faulted, and intruded by Laramide granitic rocks. On the western side are schistose conglomerate, sandstone, shale, limestone, and rhyolitic tuffs (Copper, 1971; Lacey, 1959).

Mineral Resources

Metallic Resources

The reservation lies within one of the most productive copper mining areas in the United States. Other mineral commodities, including gold, silver, molybdenum, lead, and zinc, are also common. Tribal lands lie just south of the Amole (Tucson Mountain) mining district, and north of the Pima mining district, but no mineral resources are known within the reservation boundaries. Several miles to the south of the reservation several large and important open pit mines lie within the Pima District, including Asarco's San Xavier and Mission mines, Eisenhower Mining Company's Palo Verde deposit, Pima Mining Company's Pima mine, Anamax Mining Company's Twin Butte mine, and Duval's Sierrita and Esperanza mines.

Occurrences of beryllium, uranium, iron, tungsten, thorium, zirconium, molybdenum, selenium, tellurium, antimony, cadmium, and bismuth are known on or near the San Xavier Indian Reservation, which is just south of the Pascua-Yaqui Reservation. One occurrence of uranium is immediately southeast of the Pascua-Yaqui Reservation. Vanadium molybdenum, and tungsten are found in the Tucson Mountains. General locations of occurrences are shown in Forrester, 1962.

Nonmetallic Resources

Known nonmetallic minerals are limited to occurrences of gypsum, clay, and tuff (as building stone) in the vicinity of the reservation. Although reservation deposits may exist on the reservation, the development of any such deposits would depend largely on the quality of the deposits and market conditions.

Energy Resources

Pascua-Yaqui lands lie within the Overthrust Belt, an area of active oil and gas leasing (Keith, 1980). At present, thrust belt petroleum production extends from Alberta, Canada, into Utah, and from

Chihuahua to Ver Cruz, Mexico. Arizona, in the untested central part of the belt, is experiencing a major oil and gas leasing effort. Present leasing is in a southeast trending, 150-mile-wide band from Kingman through Phoenix, Tucson, and Douglas. It is considered likely that a large overthrust brought crystalline rock over younger, hydrocarbon-bearing, sedimentary rock, and that deep drilling, often through crystalline rock, will reach this younger rock (Keith, 1980).

Pima County has been prospected only lightly for oil in the past, and only eight exploration wells were drilled by 1971; none of these tests were drilled to 5,000 feet. In 1972, a test well reached 12,500 feet before abandonment. An exploration hole 50 miles northwest of the reservation in sec. 2, T 75 N. R 10 E, Pinal County, is reportedly prepared to go to 20,000 feet, but operators expect to reach favorable rock in 8,000 to 10,000 feet (Keith, 1980).

Under present cost-risk conditions, the small size of the Pasqua-Yaqui tract does not appear to warrant the expense of a deep test well on this parcel without leases on adjoining acreage. Additional exploration information and/or petroleum production in the vicinity could alter this conclusion.

Recommendations

Although the reservation lies between three mining districts, one of which is a major copper producing area, no significant metallic mineralization has been found on the reservation. The geologic environment of the Tucson Mountains, of which the reservation is a part, does not appear to be favorable for large mineral deposits. However, geochemical studies of bedrock and stream deposits in the southern part of the Tucson Mountains combined with geologic field examination of mineralized areas would provide background information useful in evaluating the mineral resources of the reservation. Alluvial deposits in the vicinity of the reservation may be a potential source of sand and gravel, if they do not contain too much intermixed clay and silt.

PAYSON INDIAN COMMUNITY

Setting

Located about 1 mile south of Payson in SE¼ sec 9, T 10 N, R 10 E, Gila County, the Payson Indian Community includes members of the Yavapai and Tonto Bands of the Apache tribe. The smallest of the three reservations under study (85 acres), it borders Arizona State Highway 87 and is administered by the Bureau of Indian Affairs from the Truxon Canon Agency.

The Payson Indian Community lies in a transition zone between the Basin and Range physiographic province to the south, characterized by elongate, north-trending, block-faulted, mountain ranges separated by broad valleys, and the Colorado plateau province to the north, characterized by nearly flatlying mesas and incised stream channels. Sedimentary rocks of the Mogollon Rim lie to the north. The reservation itself is on the edge of the Tonto Basin, a down-faulted, sediment-filled, Basin and Range trough, lying between uplifted mountain ranges, and underlain by low-grade metamorphic greenstone (Royse and others, 1971). The reservation averages about 5,040 feet above

sea level, and most of the mountain peaks within the region are less than 5,200 feet high (Figure 4).

Previous Investigations

Past geologic studies have been mainly reconnaissance, such as regional ground water studies (Arizona Underground Water Commission, 1953), or mapping done in conjunction with the State mapping program in the 1950's (Forrester, 1962). Such studies have developed numerous small-scale geologic and mineral maps, including maps of known metallic, nonmetallic, energy, and other resources of Arizona, that cover Gila County and its Indian reservations (Forrester, 1962). Detailed mapping is available for some mines in the Green Valley Mining District. The "Directory of Active Mines in Arizona" (Turney, 1978) lists and describes all then currently active mines in the vicinity of the reservation. The "Mineral and Water Resources of Arizona" by the Arizona Bureau of Mines (1969) lists and locates various known resources. Because the reservation is small, there is no detailed knowledge of its geology and mineral resources.

Geology

Payson is in the Payson Basin, a graben structure containing extensive exposures of Proterozoic rocks (Titley, 1962) south of the Diamond Rim, (the name used for the Mogollon Rim in this area). The oldest rocks in the area are schists (not on map, Figure 5) that have been intruded by the 1,700 m.y. old Payson Granite and Gibson Complex (Conway, 1976).

The Gibson Complex covering 50-60 miles south and west of Payson (Figure 5) consists mainly of diorite but also contains some gabbro and rocks of intermediate composition (Conway, 1976). The area underlying this unit consists of a tableland of low relief. The unit consists of diorite at Gibson Peak 2½ miles southeast of Payson but becomes more mafic toward Payson where gabbro is the dominant rock type. The gabbro exhibits layering.

Intruding the Gibson Complex is the Payson granite which covers an area of 60-70 miles^2 north of the Gibson Complex. The granite is coarse to medium grained and contains quartz, feldspar, hornblende, and biotite (Conway, 1976). Both the granite and diorite are deeply weathered and poorly exposured.

Although several Paleozoic units occur near the Diamond Rim, only the Tapeats Sandstone of Cambrian age occurs as far south as Payson. The unit is distinguished by a reddish brown color and consists of a coarse grained sandstone to pebble conglomerate (Hereford, 1977). The composition of the sandstone is arkosic to subarkosic, and cross-stratification is conspicuous.

Other Paleozoic units occur only north of Payson and none are closer than 2 miles from the reservation. Alluvial fill is relatively unimportant near Payson as the valley is floored by the Proterozoic rocks.

The area near Payson itself is structurally simple but Feth (1954) indicates that the Payson basin is a graben. Also Payson lies south of one of the more structurally complex portions of the Mogollon Rim in which there may actually be three rims (Feth, 1954). The Diamond Rim is the

southernmost rim and Titley (1962) believes it may still be active.

Mineral Resources

Metallic Resources

Although tribal lands are within the Green Valley mining district, there is no mineral production on the reservation. However, several mines opened on gold-bearing quartz veins exist in the district, and a small production of gold has been obtained from placer operations near the reservation (Gilbraith and Brennan, 1970; Forrester, 1962; Arizona Bureau of Mines, 1952). Some copper and lead also are found within 8 miles of the reservation. Small deposits of the antimony mineral stibnite occur with copper ore within 7 miles to the north and west of the reservation. One occurrence of molybdenum and one of manganese are reported south of the reservation. Numerous occurrences of uranium, tungsten, iron, and tellurium are present in the Sierra Ancha Mountains to the southeast. General locations of these minerals are shown by Forrester, 1962, and mentioned by Galbraith and Brennan, 1970, and Arizona's Department of Mineral Resources, 1970. Renewed interest in the district has been generated by recent increases in gold prices. Because the reservation is in a mining district and close to gold, copper, and silver production sites, tribal lands could be investigated for these resources. Owing to the reservation's small size and nearby urban development, the ability to mine metallic resources even if they are found to exist, may be limited.

Nonmetallic Resources

To the southwest and southeast of the reservation, and within 9 miles of it, are several occurrences of barite and one operation that produces sand and gravel and crushed stone. One sand and gravel company is headquartered in Payson. The tribal land itself does not contain extensive alluvial deposits. Recent stream deposits may be present, but such deposits would almost certainly be small and uneconomic.

Energy Resources

No oil exploration test holes have been drilled in the vicinity of the tribal lands because of the unlikelihood of finding petroleum in the metamorphic and crystalline basement rocks beneath the reservation. No coal is present in the immediate vicinity, although Paleozoic carbonaceous material is known to the north in the Mogollon Rim area (Peirce and others, 1970, p. 12 and 13).

Recommendations

Although no mineral commodities have been reported as occurring within the Payson Indian Community, the presence of mineralization in geologically similar nearby areas indicates that mineralization is also possible within the Payson Indian Community. Geochemical examination might help to assess the mineral resources of the area but the outlook for success is relatively unfavorable.

CAMP VERDE RESERVATION

Setting

Located in central Arizona between Phoenix and Flagstaff in Yavapai County, the Camp Verde Reservation consists of five parcels of land that total about 650 acres and are occupied by the Yavapai Apache Tribe. Tribal affairs are handled through the Bureau of Indian Affairs, Truxton Canon Agency. Tribal headquarters is in the Middle Verde Parcel, consisting of 458 acres in secs. 11 and 14, T 14 N, R 4 E. This parcel is within a large bend of the Verde River and almost entirely in the Coconino National Forest. The Lower Verde Parcel comprises 55 acres in lot 6, sec. 32, T 14 N, R 5 E, and is on the southeast edge of the community of Camp Verde.

The reservation has an additional 137 acres in three tracts (Figure 6) designated as (1) the Rim Rock Parcel, 3.76 acres in NE¼ sec. 2, T 14 N, R 5 E, (a field examination indicates the tract is probably in NW¼NW¼ sec. 1) on the western edge of the community of Lake Montezuma (about 6 miles northeast of Camp Verde), (2) Tract 37, 74.84 acres in sec. 18, T 14 N, R 5 E, about 3 miles north of Camp Verde, and (3) the Clarkdale Parcel of 58 acres (sometimes called the Yavapai Parcel), northwest of Camp Verde near Clarkdale.

Physiographically, the five parcels of the Camp Verde Indian Reservation lie within a transition zone between the Colorado Plateau province to the north, characterized by nearly flat lying strata with incised canyons, and the Basin and Range province to the south, characterized by elongated, north trending, block-faulted mountains separated by broad valleys. The Camp Verde parcels lie on nearly flat land within a broad alluvial-filled valley along or close to the Verde River, on Cenozoic sedimentary rocks of the Verde Formation, or on Quaternary deposits consisting of varying amounts of sand, gravel, and silt (Twenter and Metzger, 1963). To the west and east lie nearly horizontal Paleozoic sedimentary beds, overlying granitic and schistose basement rocks, and partially overlain by basalt, tuff, and agglomerate. The varying parcels of land range from approximately 3,100 to 3,700 feet in elevation.

Previous Investigations

Past geological studies have been mainly reconnaissance, such as regional ground water studies (Arizona Underground Water Commission, 1953), or mapping done in conjunction with the State mapping program in the 1950's (Forrester, 1962). This approach has resulted in the development of numerous small scale geologic and mineral maps, including maps of known metallic, nonmetallic, and energy resources of Arizona, that cover Yavapai County and the Indian reservations (Forrester, 1962). Detailed mapping and investigations have been done for individual mining claims and mines in the Black Hills to the west of the parcels, particularly in the Jerome area (Reber, 1922; Lindgren, 1926; Anderson and Creasey, 1958).

"The directory of active mines in Arizona" (Turney, 1978) lists and describes all then currently active mines in the vicinity of the reservation. The "Mineral and water resources of Arizona" by the Arizona Bureau of Mines (1969) lists and locates various resources in Arizona. A geologic map of the Clarkdale Quadrangle (Lehner, 1958) and a

geology and ground water map of the Verde Valley area (Twenter and Metzger, 1963) show detailed geology in the area and some locations of quarries, mines, and oil-test wells.

There have been no detailed studies of mineral resources in the reservation parcels despite their proximity to major mining districts. This lack is attributable to the small size of the parcels and their situation in areas of deep alluvium, and (or) sedimentary rocks with few outcrops.

Geology

The Camp Verde Reservation is in Verde Valley within the transition zone between the Colorado Plateau and the Basin and Range provinces (Twenter and Metzger, 1963). Verde Valley is a northwest-trending downfaulted basin that is filled with Cenozoic sedimentary and volcanic rocks, and surrounded by hills of Proterozoic, Paleozoic, and Cenozoic rocks (Twenter and Metzger, 1963). Jenkins (1923) provided the first detailed study of the sedimentary rocks within the valley, and subsequent studies by Lehner (1958), Twenter and Metzger (1963), Bressler and Butler (1978) and Nations (1974) have added considerable new information.

On the western side of Verde Valley, Proterozic rocks of the Yavapai Series form the Black Hills. They consist of lava flows, breccias, agglomerates, and tuffaceous sedimentary rocks that have been intruded by Precambrian diorite and quartz prophyry (Twenter and Metzger, 1963). These Proterozoic rocks are separated from the Cenozoic rocks of the Verde Valley by the Verde Fault. Around the valley to the north and northeast are Paleozoic sedimentary strata ranging in age from Cambrian to Permian. Northeast and east of the Verde Valley are Tertiary fluviatile and lacustrine sedimentary rocks and Tertiary basalts. The volcanic rocks cover an extensive area. One of these flows was once thought to have blocked the Verde River causing a lake to form that resulted in the Verde Formation which fills the valley today (Jenkins, 1923), but more current evidence suggests that the lake formed as a result of subsidence after the lava flows had been deposited (Bressler and Butler, 1978).

The Verde Formation (see Figure 7) consists of limestone, sandstone, evaporites, interbedded volcanic rocks, and conglomerates. The tuffaceous sediments and lavas are found at the south end of the valley and thin northward. They intertongue with the clastics that contain the evaporites. Evaporites extend over 75 mi^2 in the southwestern part of the valley, close to the Lower Verde, Tract 37, and Middle Verde parcels. In general, coarse clastics were deposited along the margins of the basin and fine-grained sediments, particularly limestone accumulated in the central part. The Verde Formation is estimated to be about 2,000 feet thick. Sinkholes and slump blocks occur around McGuireville, Montezuma Castle, and southeast of Camp Verde. The Verde Formation contains numerous fossils including gastropods, pelecypods, ostracods, oogonia, teeth, bones, seeds and pods, and plant fragments. Several fossil localities including some possible elephant prints (Brady and Seff, 1959), are near the Tract 37 Parcel and the Rimrock Parcel (Twenter, 1962). Nations (1974) envisioned a marshy flat-floored valley crossed by a stream emptying into a lake, which fluctuated in size with the season, at the southern end of the Basin.

Gravels eroded from the Black Hills cover a 4 to 5 mile wide strip between the Black Hills and the Verde River. These gravels cover the pediment developed on the Verde Formation and may be as much as 25 feet thick. The size of the fragments becomes smaller away from the Black Hills, and they are at best moderately cemented.

Along the course of the Verde River are terrace and stream deposits of unconsolidated gravel, sand, silt and clay.

Mineral Resources

Metallic Resources

Tribal lands are close to or in the Verde (Jerome) and Camp Verde mining districts, but no known mining has occurred within the reservation. Numerous occurrences of nonferrous base and precious metals (copper, lead, zinc, gold, silver) are recorded throughout the Black Hills to the west of the parcels, particularly in the vicinity of the towns of Jerome and Cherry (Figure 6), and at a site approximately 5 miles south of Camp Verde. The inactive United Verde mine and its extensions are in schistose basement rocks north of Jerome, and a smelter at Clarkdale. The mine operated between 1918 and 1940, and was one of the most important copper, gold, and silver producers in the United States (Alenius, 1968). No metal occurrences are known near any of the reservation parcels.

In the Black Hills, however, are found occurrences of thorium, iron, antimony, molybdenum, cobalt, and the rare earths (Forrester, 1962). The Black Hills have been uplifted relative to the Verde Valley; thus metallic resources in the hills and near Jerome occur in strata stratigraphically lower in the section that the rock underlying the reservation parcels. If present, any mineral resources would be buried under alluvium and sedimentary rocks in the down-dropped Verde Valley. Uranium and vanadium occur 7 miles northeast of Clarkdale, and molybdenum, selenium and tungsten are found within 9 miles of Camp Verde. Certain plants in the Upper Verde Valley carry toxic amounts of selenium obtained from the soil, and crystals of selenium have been found in the United Verde mine (Moore, 1953, p. 18). Unpatented lode claims are staked at one tungsten prospect in the Camp Verde district in sec. 14, T 13 N, R 4 E, about 3 miles southwest of Camp Verde. Twelve claims, the "Tungsten King Prospect", are described in the Bureau of Mines Information Circular 8078, 1961, p. 62-64. Two grab samples from surface material assayed 0.18 and 1.40 percent scheelite, a tungsten ore. Some copper minerals also were found but not assayed.

Nonmetallic Resources

Principal nonmetallic commodities produced in the area are gypsum, limestone, sandstone, and clay. The limestone and sandstone are produced near and to the north of Clarkdale (Lehner, 1962) from outcrops of Paleozoic rocks. Halite, sodium sulfate, and diatomite also occur in the vicinity of one or more parcels. An inoperative halite (salt) quarry is present 1.5 miles south of the town of Camp Verde, and a gypsum mine is 4 miles southeast of that town. Gypsum and clay mined in the Verde Valley from the Verde Formation are used in cement manufacture near Clarkdale (U. S. Bureau of Mines, 1979). Near the salt mine south-

east of Camp Verde is one of the largest stadium sulfate deposits in the world. The minerals found there included thenardite, mirabilite, and glauberite in a layer 15 feet thick overlain by a 25-foot-thick saliferous silt and clay layer (Feth, 1954). Material from clay-shale quarries in the vicinity of the reservation is used to produce brick, tile, and building material. Thus, the possible existence of gypsum or clay and possibly building stone on the reservation should be investigated. Present supply and demand would need to be evaluated, but occurrences, if present,would need to be high quality to be economic.

Sand and gravel is present along the Verde River and its tributaries, and possibly within older alluvial deposits, but no records of mining or resource use on the reservation are found. Two sand and gravel producers are headquartered in Camp Verde (Turney, 1978). Owing to the proximity of the reservation parcels to the Verde River, sand and gravel availability could be investigated.

Energy Resources

Petroleum exploration in the vicinity of the tribal lands has disclosed only a thin mantle of sedimentary rocks over crystalline basement rocks. Available records show that exploration drilling nearest to tribal lands consisted of two shallow wells drilled in 1913. The tests were drilled southeast of the Lower Verde Parcel in secs. 9 and 14, T 13 N, R 5 E, a distance of 2 and 4 miles, respectively, from the parcel (Stipp and Beikman, 1959; Twenter and Metzger, 1963). The wells in sec. 9 and sec. 14 reached igneous rocks at 1,225 feet and 1,625 feet respectively. Another test well was drilled in 1959 in sec. 20, T 16 N, R 4 E (about 6 miles east of the Clarkdale Parcel). Drilling ended at a depth of 1,485 feet in unspecified Tertiary rock (Stipp and Beikman, 1959).

Since 1963, 18 exploration test holes have been drilled in the Oak Creek-Verde Valley area, most of them 6-10 miles northeast of the Clarkdale Parcels (Figure 8). Eleven are known to have reached Precambrian basement rock. All tests were "dry" holes, although unsubstantiated claims of oil showings have been made. These exploration holes are further discussed by Peirce and others, 1970. One factor which makes drilling attractive in thisarea is that the local geologic setting places the possible oil-bearing, lower Paleozoic rock within 1,555 feet of the valley surface. These lower Paleozoic sedimentary strata are of principal interest, consisting of coarse-grained sandstone and carbonate rocks. It seems likely that the principal drilling objective of past exploration efforts was the basal portion of the Martin Limestone in a porous, odorous dolomite. This unit, which could act as both a source and reservoir rock, is overlain by a seemingly impermeable barrier of dolomite.

The complex geologic history of the area, including the probability of two episodes of regional tilting, folding, volcanism, faulting, and thrusting, may have tended to rearrange the geometry of the rocks, adjusting stresses and possibly producing traps for hydrocarbons. Moreover, the location of the Camp Verde Reservation within the Overthrust Belt provides a possibility for deeply buried petroleum deposits in sedimentary rocks underlying the crystalline rocks. Thus, even though the region presently has no active wells, nor confirmed oil showings, actual geologic conditions still hold some promise for petroleum occurrence.

Recommendations

Examination of the southern parcels may reveal evaporite sequences near to the surface that may possibly contain small quantities of the evaporite minerals.

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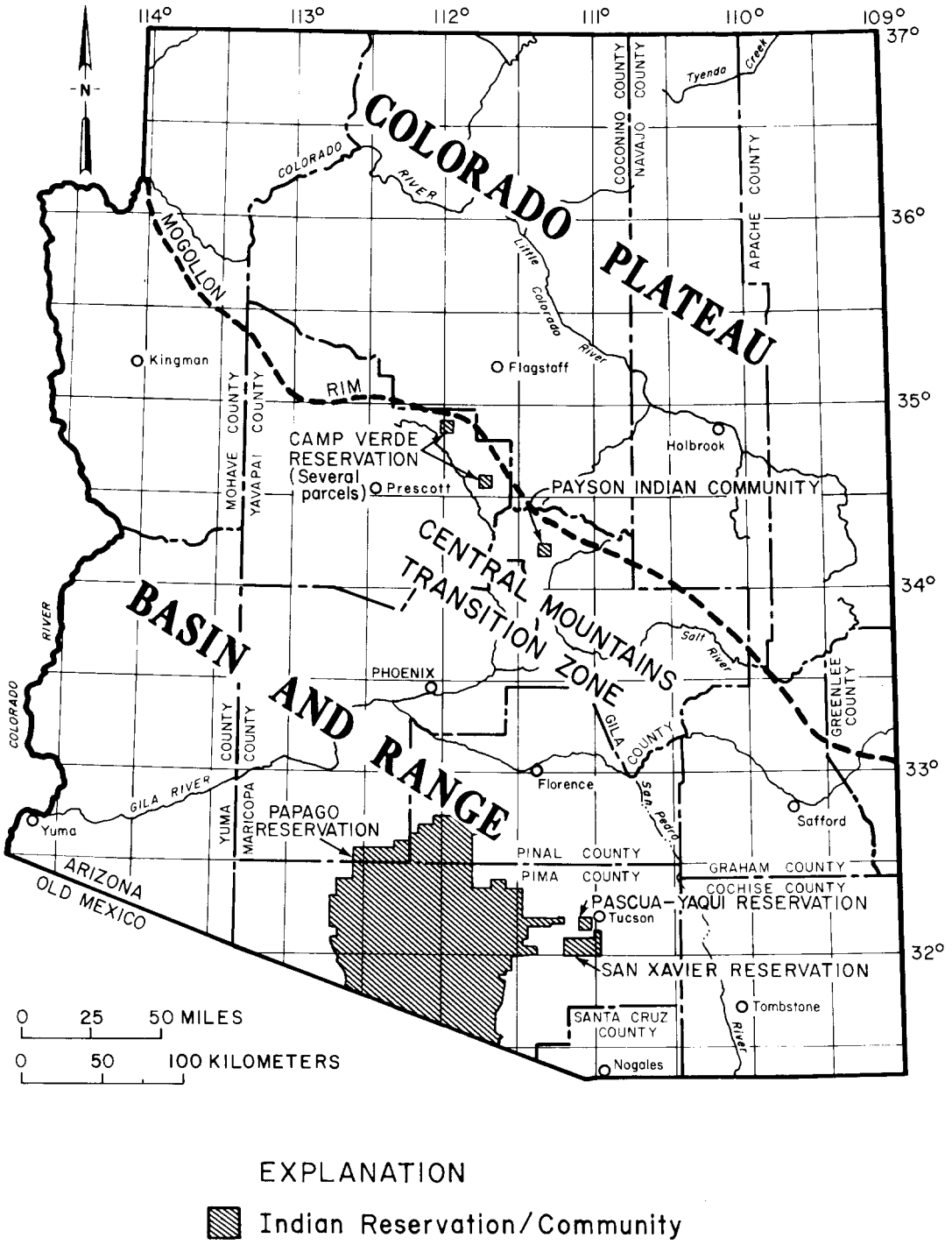

Figure 1. Map of Arizona showing the location of the Pascua-Yaqui and Camp Verde Indian Reservations and the Payson Indian Community.

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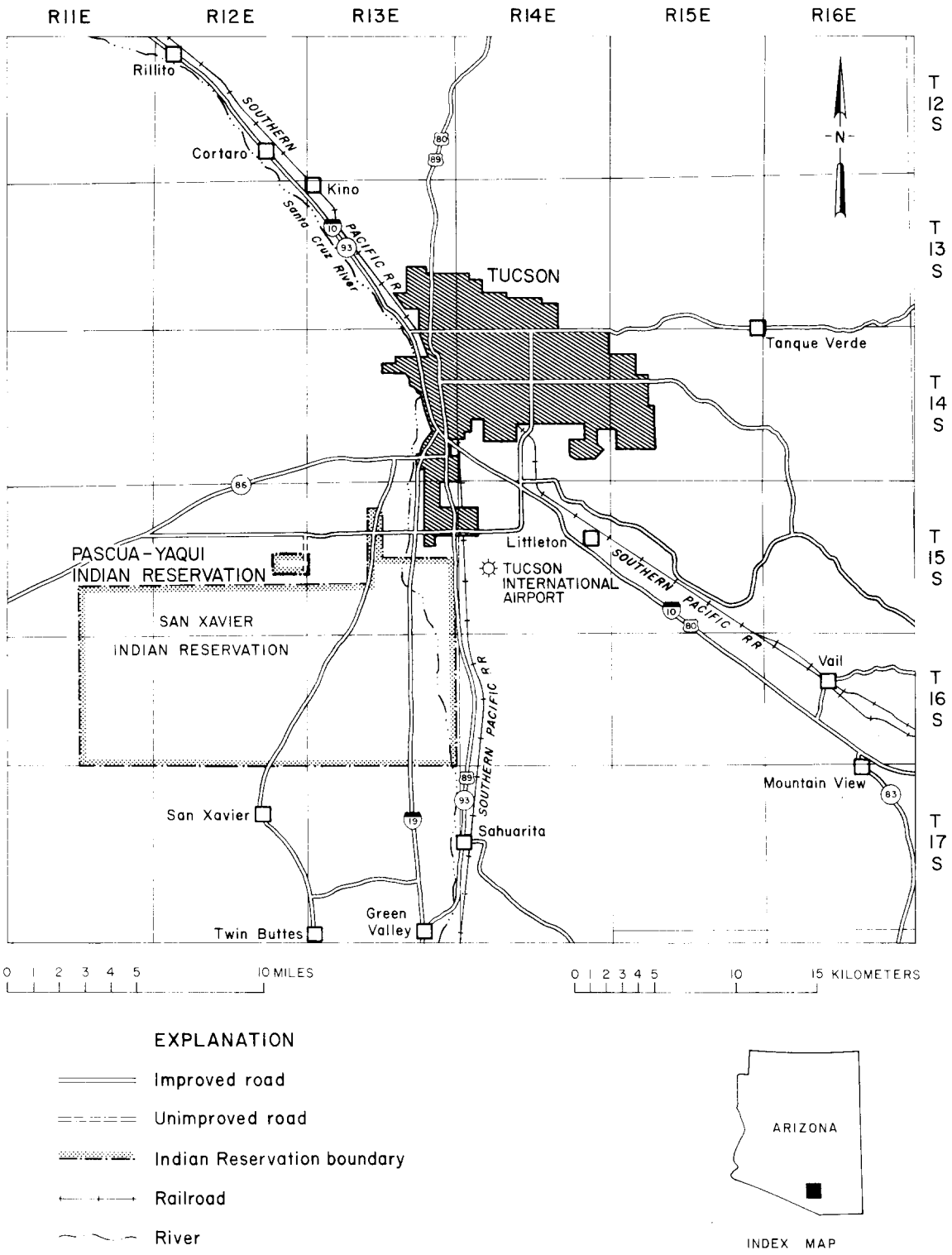

Figure 2. Index map of the Pascua-Yaqui Indian Reservation and vicinity, Pima County, Arizona.

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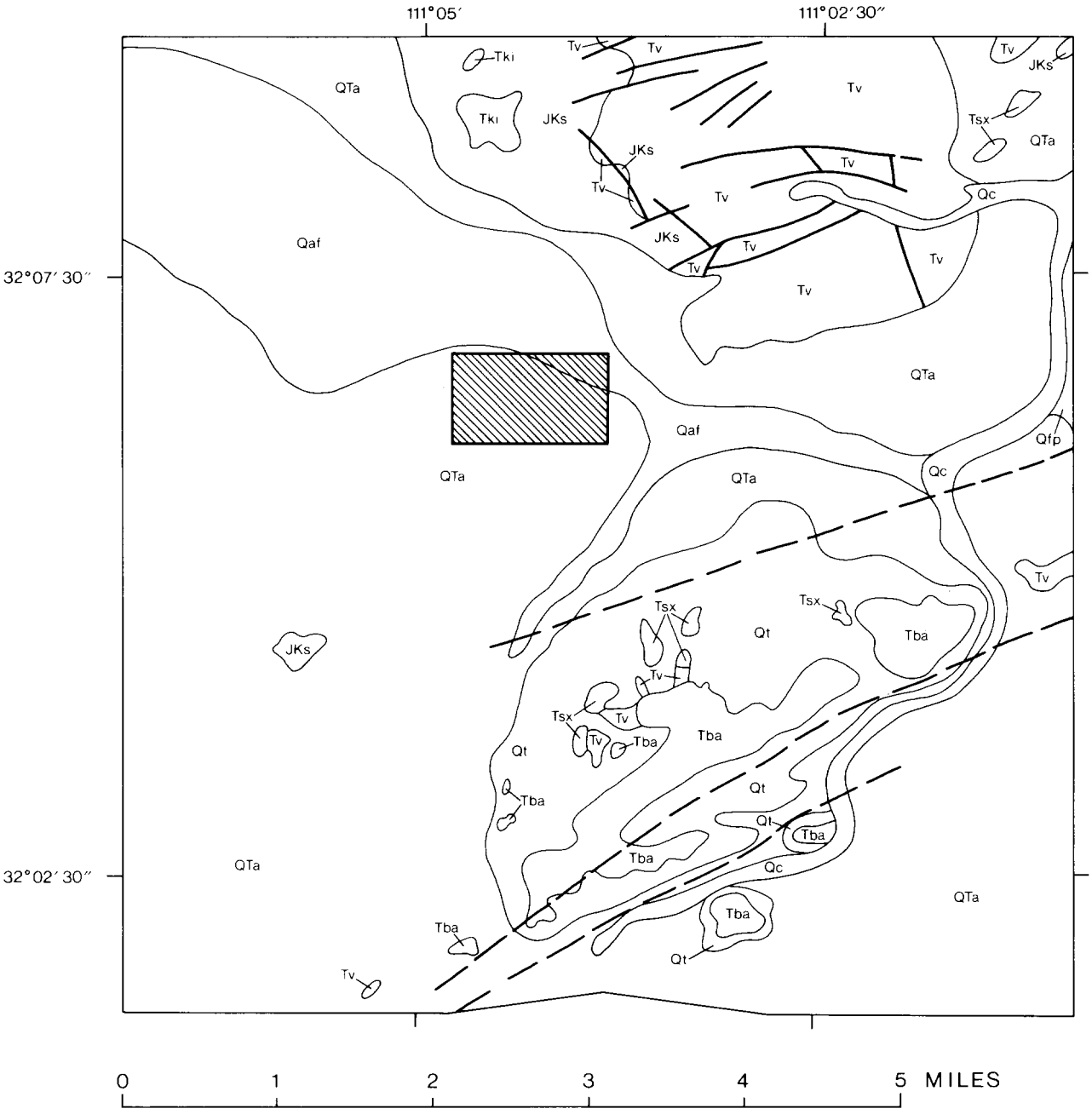

Figure 3. Geologic map of the Pascua-Yaqui Indian Reservation and surrounding area (modified from Heindl, 1959, and Brown, 1939). See Figure 3a for explanation.

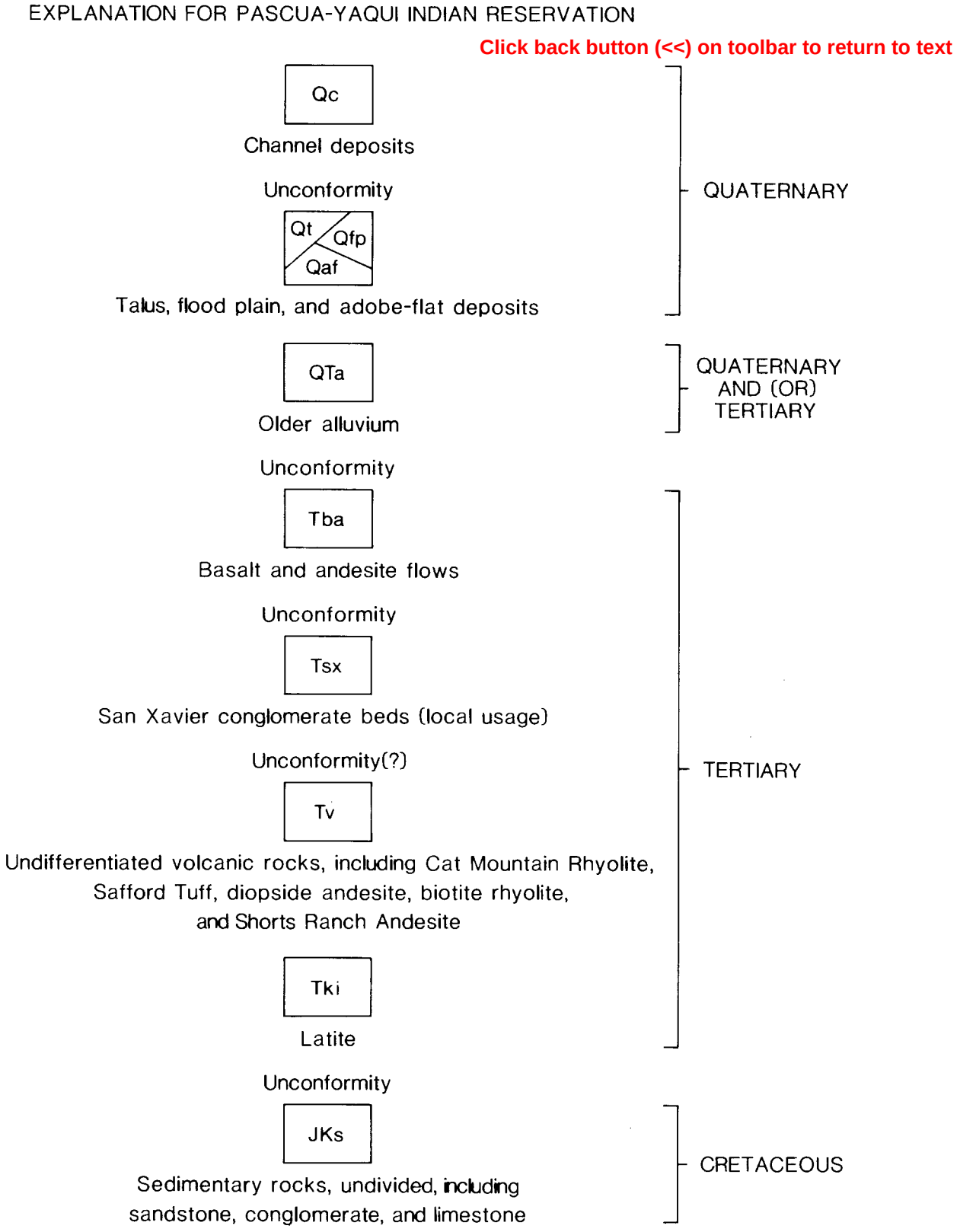

Figure 3a. Explanation for geologic map, Figure 3.

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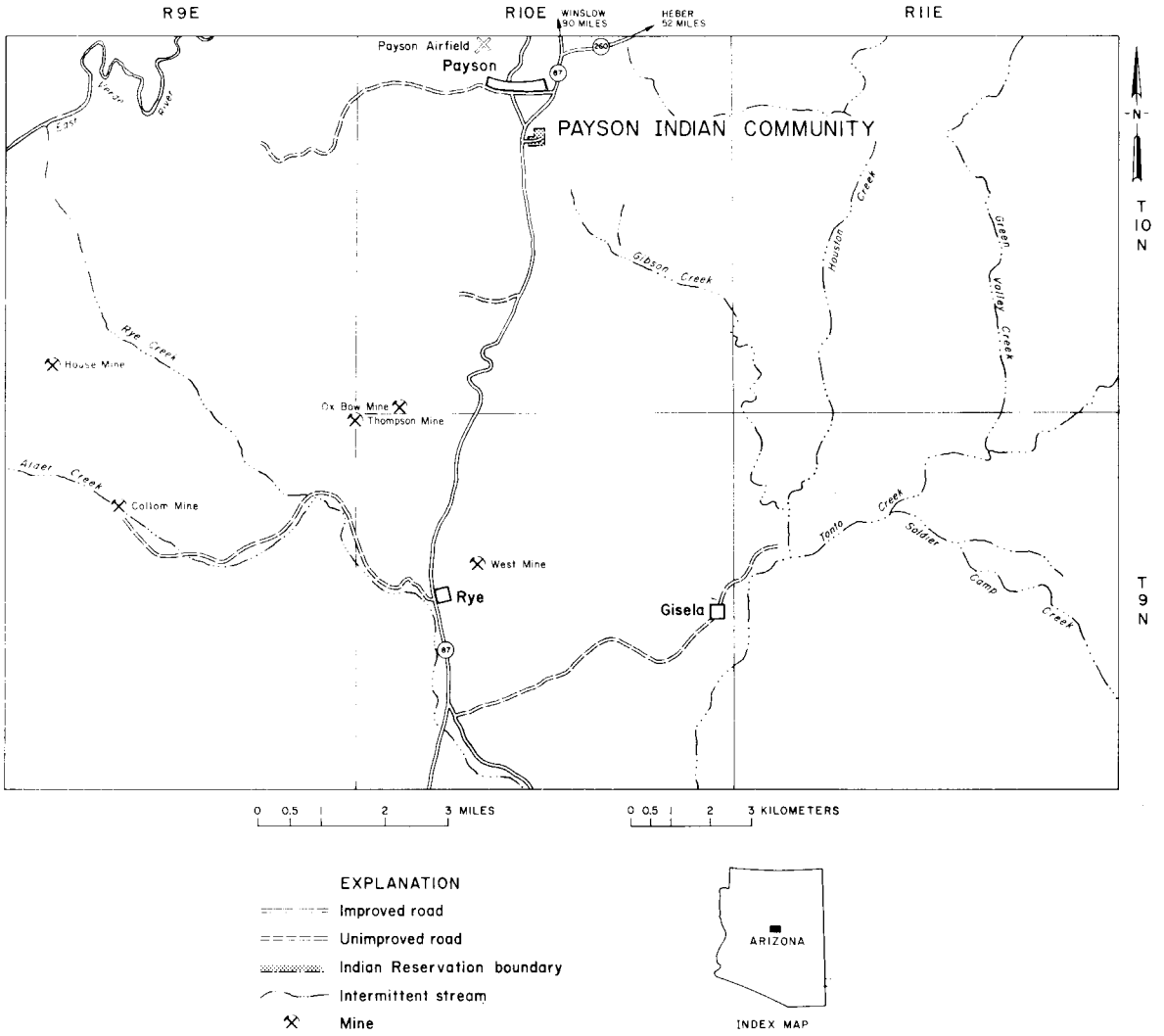

Figure 4. Index map of the Payson Indian Community and vicinity, Gila County, Arizona.

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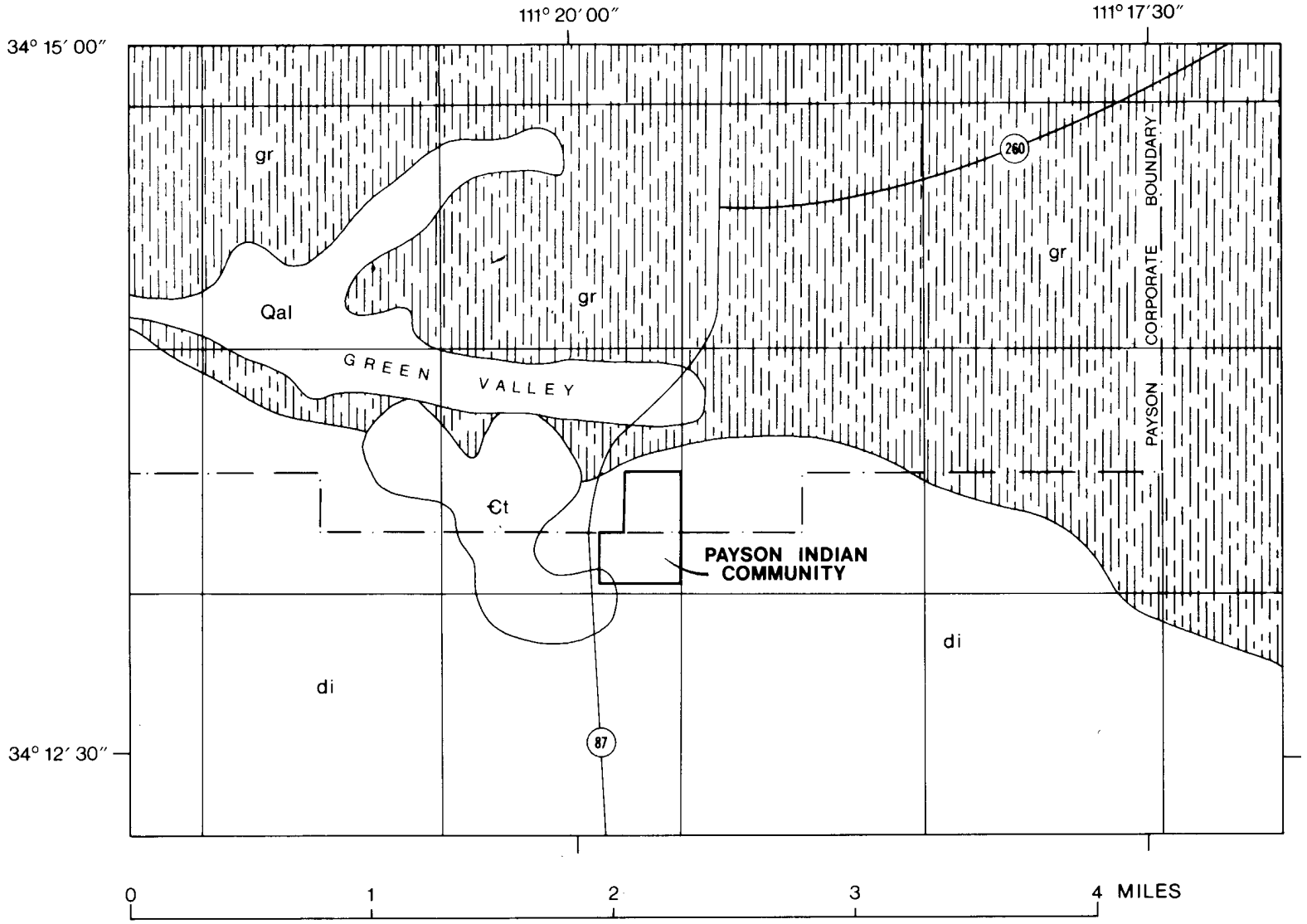

Figure 5. Geologic map of the Payson Indian Community and surrounding area (from Conway, 1976). See Figure 5a for explanation.

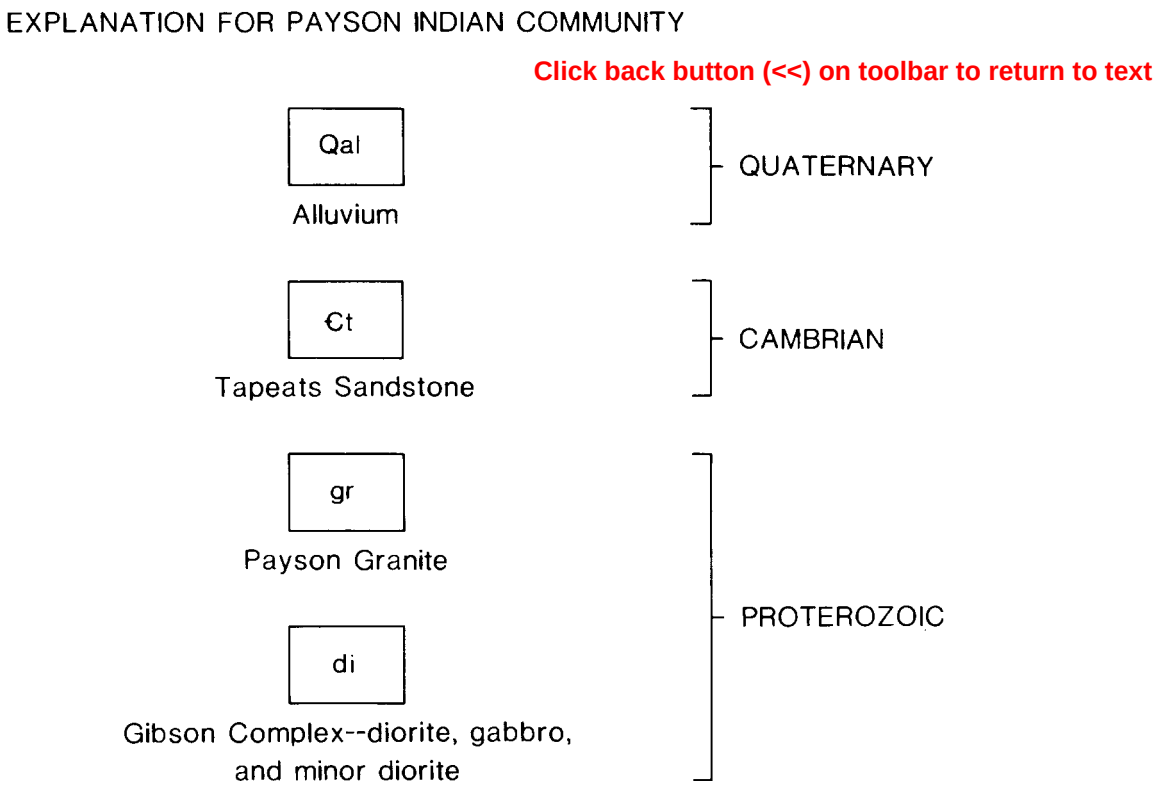

Figure 5a. Explanation for geologic map, Figure 5.

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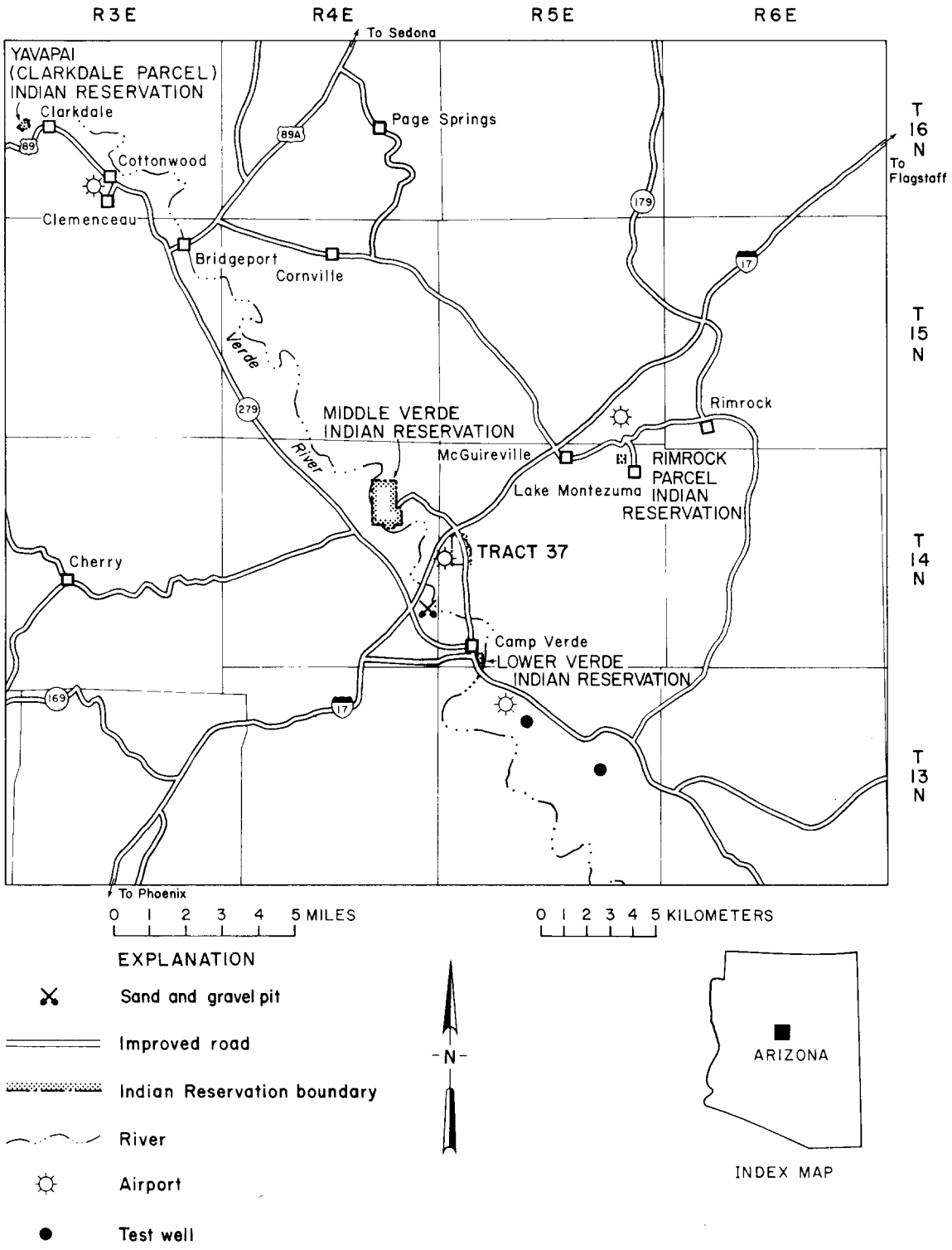

Figure 6. Index map of the Camp Verde Indian Reservation, Yavapai County, Arizona.

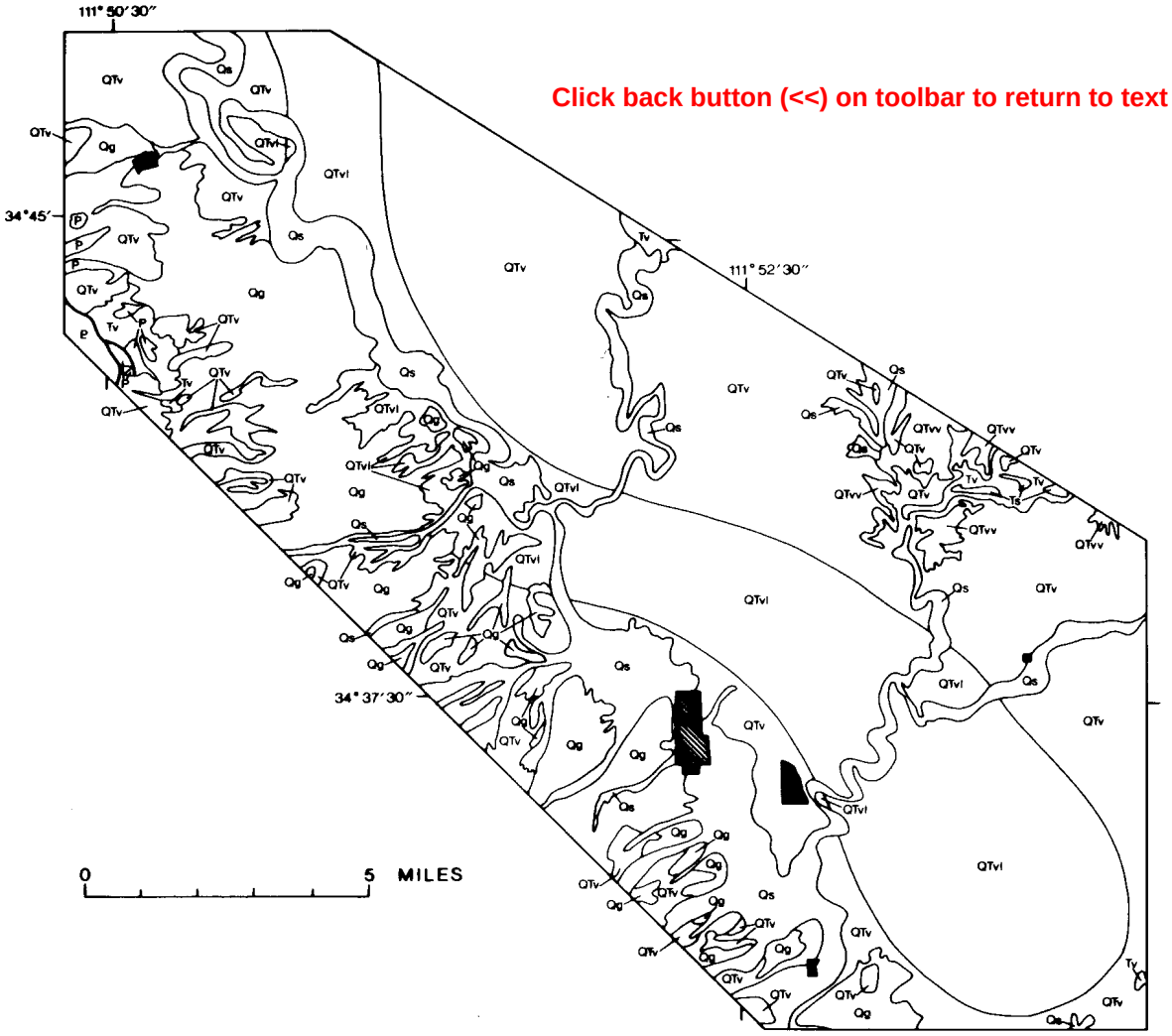

Figure 7. Geologic map of the Camp Verde Indian Reservation and surrounding area (from Twenter and Metzger, 1963). See Figure 7a for explanation.

EXPLANATION FOR CAMP VERDE INDIAN RESERVATION

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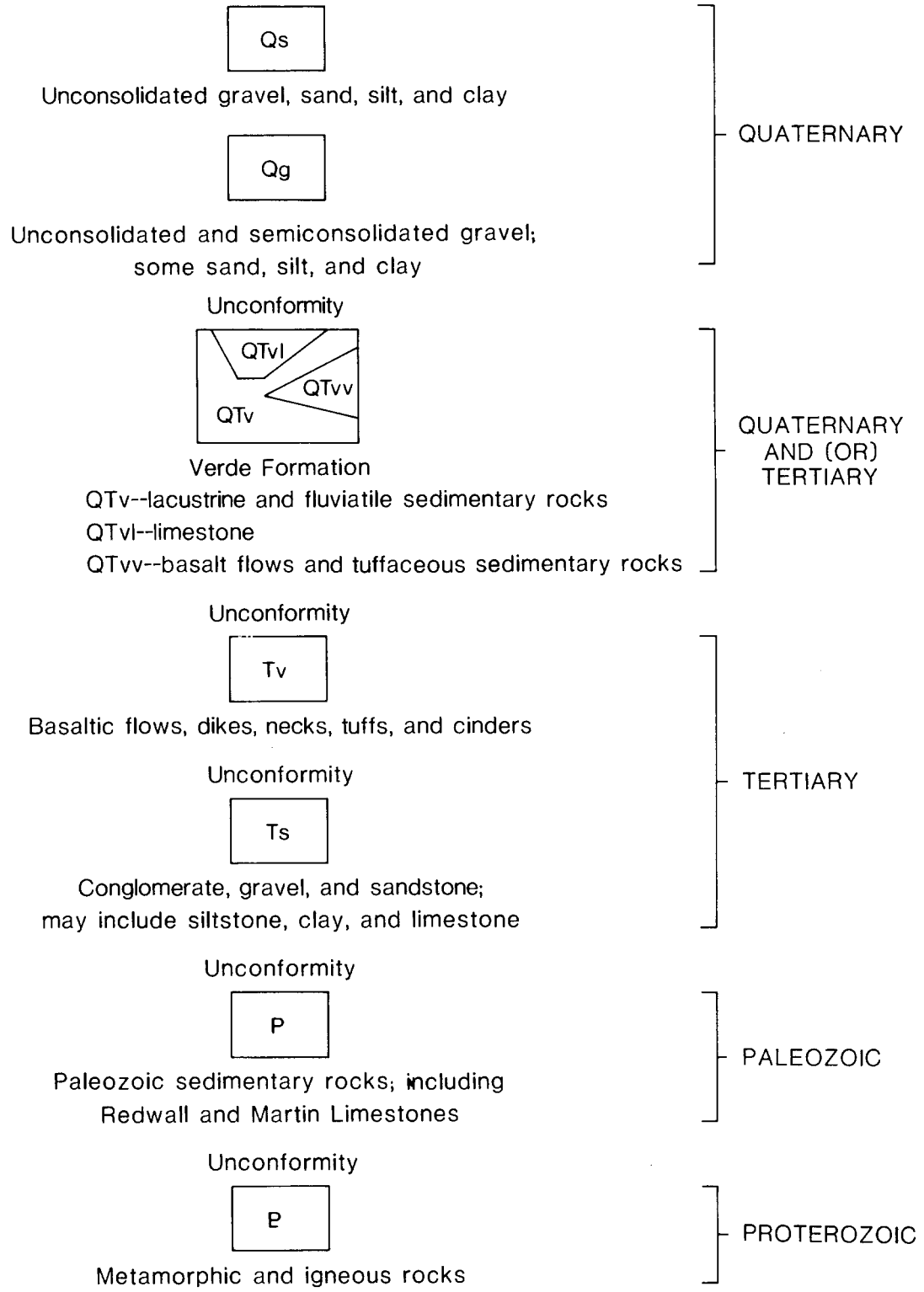

Figure 7a. Explanation for geologic map, Figure 7.

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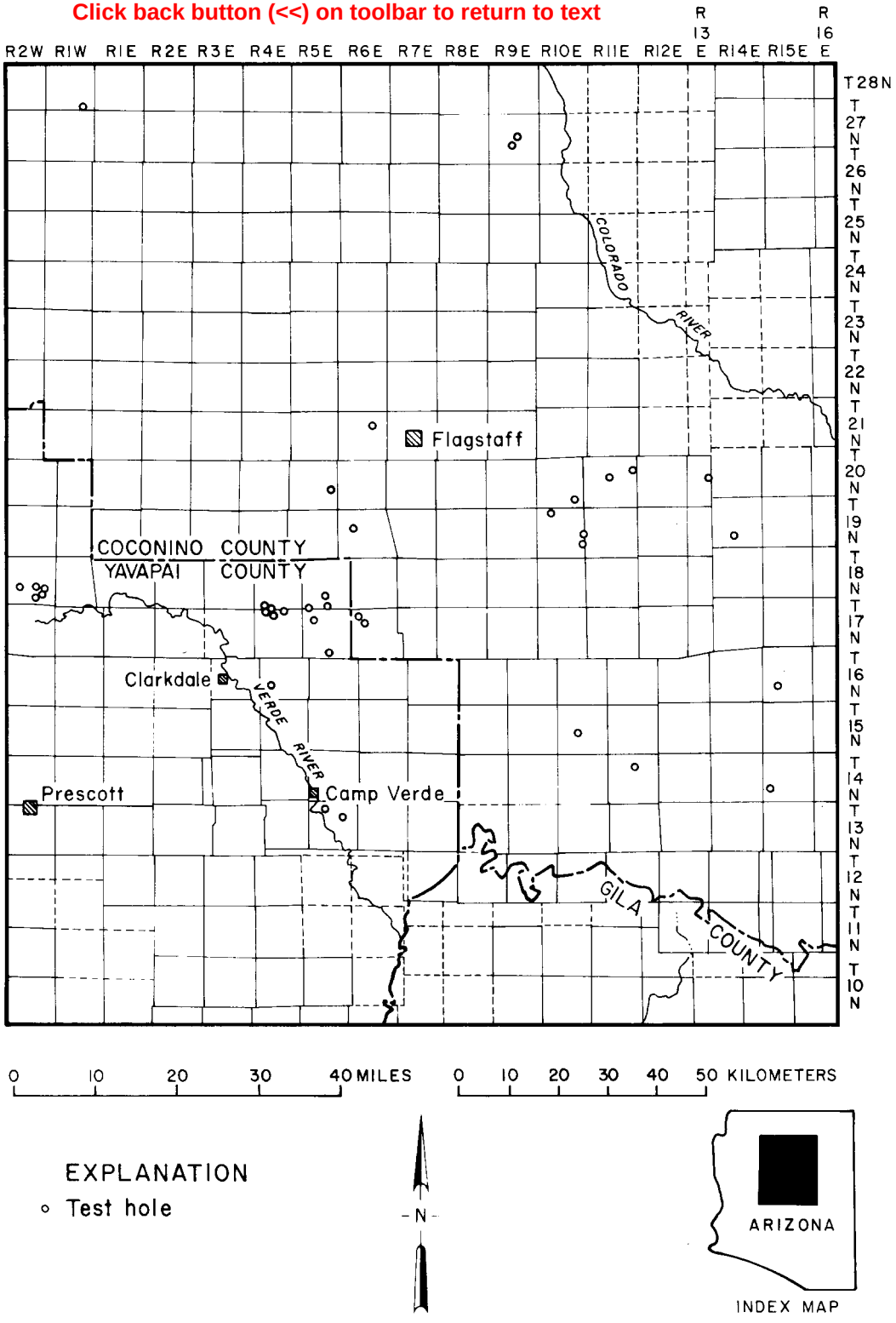

Figure 8. Location of oil and gas test holes in vicinity of Camp Verde Indian Reservation.